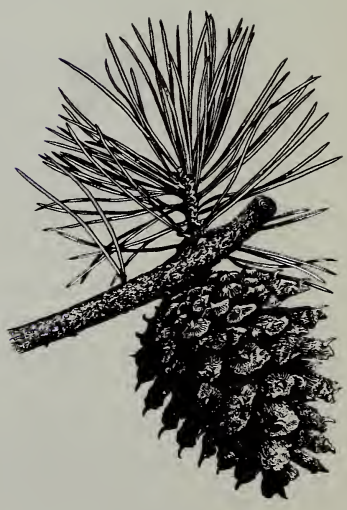
Silvical Characteristics of Virginia Pine

(Pinus virginiana)

by Albert G. Snow, Jr.



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Preface

MUCH of the silvical information on our forest trees is widely scattered and sometimes difficult to find. To make this material more readily available, the Forest Service is assembling information on the silvical characteristics of all the important native forest tree species of the United States. It is expected that this information will be published as a comprehensive silvics manual.

This report presents the silvical characteristics of one species. It contains the essential information that will appear in the general manual but has been written with particular reference to the species in the Northeast. Similar reports on other species are being prepared by this Experiment Station, and by several of the other regional forest experiment stations.

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About the Author ...

ALBERT G. SNOW, JR. *was graduated from Washington State University in 1933 with a Bachelor's degree in forestry and from Yale University 2 years later with a Master's degree in tree physiology and plant pathology. In 1935 he joined the U.S. Forest Service, Northeastern Forest Experiment Station, in New Haven, doing research on spruce management and forest genetics. Then for 10 years he served with the Southeastern Forest Experiment Station in Lake City, Florida, working on naval stores. He returned to the Northeastern Station in 1952 for assignment at the Station's research center at Laurel, Maryland. He is now center leader at Laurel.*

The Virginia Pine

VIRGINIA PINE has finally attained its rightful place among trees of commercial importance. It has done so in spite of being called "scrub pine" and "poverty pine"--and in spite of the term "forest weed", which has lingered long in the speech of oldtimers who remember the days of timber-plenty.

Virginia pine *(Pinus virginiana* Mill.*)*, which is known also as Jersey pine, North Carolina pine, and spruce pine, does so well at taking over abandoned lands that it now covers over half a million acres in Pennsylvania and Maryland alone. It is assuming a commercial importance that it has not had before, and foresters have begun to treat it with a degree of respect.

This status of respect has been stimulated by professional foresters and many production men in the wood-using industries. They have found that Virginia pine now has a definite place in fulfilling the requirements of a large and steady market for pulpwood, with lesser amounts going into lumber, structural timbers, poles, and piling. It is the principal pine species in the pulpsheds of several large pulp mills.

Virginia pine occurs generally throughout the northern parts of the Piedmont and foothills of the mountains from central Pennsylvania southwestward to northeastern Mississippi, Alabama, and northern Georgia (fig. 1). It is also found on the western edges of the Coastal Plain as far north as New Jersey and New York, and extends westward in scattered areas into Ohio, southern Indiana, and Tennessee *(39)*.

Habitat Conditions

CLIMATE

The average annual precipitation in the commercial range of Virginia pine varies from 35 to 45 inches, and is fairly well distributed throughout the year *(2, 71)*. The only exception is the southern portion of the Piedmont, where average rainfall may exceed 50 inches *(69, 71)*. In general the climate of this range is classed as humid *(66)*.

Average summer temperatures range from 70° to 75° F.; winter temperatures range from 25° to 40° F. *(2, 69, 71)*. The average number of frost-free days varies from over 225 on the eastern and southern edge of the Piedmont to 160 days in the more mountainous parts to the west and north *(69)*.

SOILS & PHYSIOGRAPHY

Virginia pine grows well on a wide variety of soils derived from crystalline rocks, sandstones, and shales, and, to a lesser extent, from limestone *(2, 43)*. After removal of the forest by cutting or fire, these soils are subject to moderate sheet and gully erosion, which may become severe on shale soils. On many areas that now support Virginia pine, much of the A horizon is gone because of past erosion under intensive agricultural use *(45, 68)*.

However, when stands of Virginia pine become established, they protect the soil about as well as stands of the oak-hickory type. In one study of water infiltration, runoff from 30- and 60-year-old Virginia pine stands averaged about 4 percent at a rainfall intensity of $1\frac{1}{2}$ inches per hour *(1)*.

The species grows best on clay, loam, or sandy loam; it generally does poorly on shaly soils and on very sandy soils, such as dune sands along the coast *(62)*. It will thrive only in moderately well-drained to well-drained soils, and is distinctly less tolerant of wet sites and impeded drainage than pitch and loblolly pines. Virginia pine generally tolerates soil acidities ranging from a pH of 4.6 *(59)* to 7.9 *(54)*. It comes in freely on abandoned farm lands throughout its range.

The best development of Virginia pine is at elevations of 100 to 2,500 feet. In Pennsylvania it occurs mostly on impoverished soils and the tops of hills and ridges less than 1,000 feet in elevation *(62)*, but is found up to 2,000 feet *(43)*.

BIOTIC

Virginia pine grows often in pure stands, most often as a pioneer species filling in on old fields. In the Society of American Foresters' classification of forest cover types *(60)*, this is listed as Type 79. Virginia pine also grows in mixture with shortleaf pine (SAF Type 77) and in a transition forest classed as Virginia pine-southern red oak (SAF Type 78). The species is also found as a component in 11 other forest cover types.

The principal tree associates of Virginia pine are shortleaf pine *(Pinus echinata)*, white oak *(Quercus alba)*, chestnut oak *(Quercus prinus)*, southern red oak *(Quercus falcata)*, black oak *(Quercus velutina)*, scarlet oak *(Quercus coccinea)*, sweetgum *(Liquidambar styraciflua)*, red maple *(Acer rubrum)*, and black gum *(Nyssa sylvatica)*. Pitch pine *(Pinus rigida)*, loblolly pine *(Pinus taeda)*, or eastern red cedar *(Juniperus virginiana)* may also be present *(60)*. Other common associates at the higher elevations *(43)* are table mountain pine *(Pinus pungens)* and white pine *(Pinus strobus)*.

In central Pennsylvania two ground-cover types have been found to be indicators of site quality for Virginia

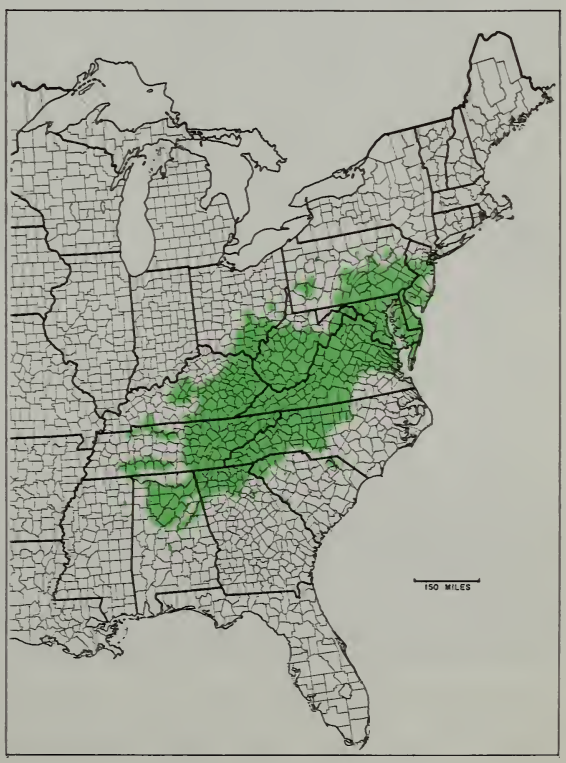

Figure 1. *The natural range of Virginia pine.*

DISTRIBUTION MAP BY
ELBERT L. LITTLE, JR.
U.S. FOREST SERVICE

pine *(6)*. The flowering dogwood-clubmoss *(Cornus florida-(Lycopodium)* type indicates the better sites with a site index between 50 and 70, and the bear oak-reindeer moss *(Quercus ilicifolia-Cladonia)* type indicates average and poorer-than-average sites with a site index between 30 and 50.

Life History

SEEDING HABITS

Flowering & Fruiting

Male flowers occur in clusters at the base of new growth, generally in the lower portion of the crown. Female flowers appear singly, in pairs, or in whorls along the basal parts of new shoots. Unlike many other pines, Virginia pine produces cones in all portions of the crown *(14)*.

Pollen-shedding and female cone receptivity start about the middle of March in the southern portion of the species' range *(18)*, and as late as the latter part of May in the northern part. Fertilization occurs in early June in ovules pollinated 13 months earlier *(65)*. The cones mature between September and November of the second year after formation.

Mature cones are reddish-brown, with prominent umbos ending in a slender persistent prickle. Cone size varies considerably among trees; the average is about 4 to 6 centimeters long (fig. 2). Empty cones may remain on a tree for 15 years, and usually persist for at least 5 years. About 3 pounds of seed may be expected from 100 pounds of fresh cones *(70)*.

Seed Production & Dissemination

The most important factor that influences cone and seed production is growing space. Open-grown trees often produce cones as early as 5 years of age. In dense stands cone production is delayed, often as long as 50 years. As stands become more open, cone production is accelerated *(54, 59, 62)*.

Although some cones are produced each year *(59)*, recent evidence suggests heavy seed crops at intervals of three or more years *(9, 14)*. However, good cone crops are sometimes produced in two successive years. Our current studies indicate that peak seed years do not necessarily

coincide throughout the range of the species.

The number of seeds per cone, and their viability, vary greatly from year to year *(2, 59, 63)*. Germinative capacity varies from 30 to 90 percent *(70)*. No differences in germinative capacity of seeds from different parts of the cone have been found *(63)*. Seed size is also variable: the number per pound ranges from 40,000 to 78,000 *(59, 70)*.

Seeds start to fall by the end of October, and over 80 percent are on the ground within 2 months. Most of the seeds fall within 100 feet of trees averaging 60 feet in height (fig. 3). Adequate stocking is often found at greater distances, particularly on the lee side of a seed source *(62)*.

VEGETATIVE REPRODUCTION

Sprout growth on Virginia pine is rare. Occasional cut stubs produce a few short-lived sprouts from dormant buds. In the seedling stage a few axillary buds occurring immediately above the cotyledons commonly elongate during

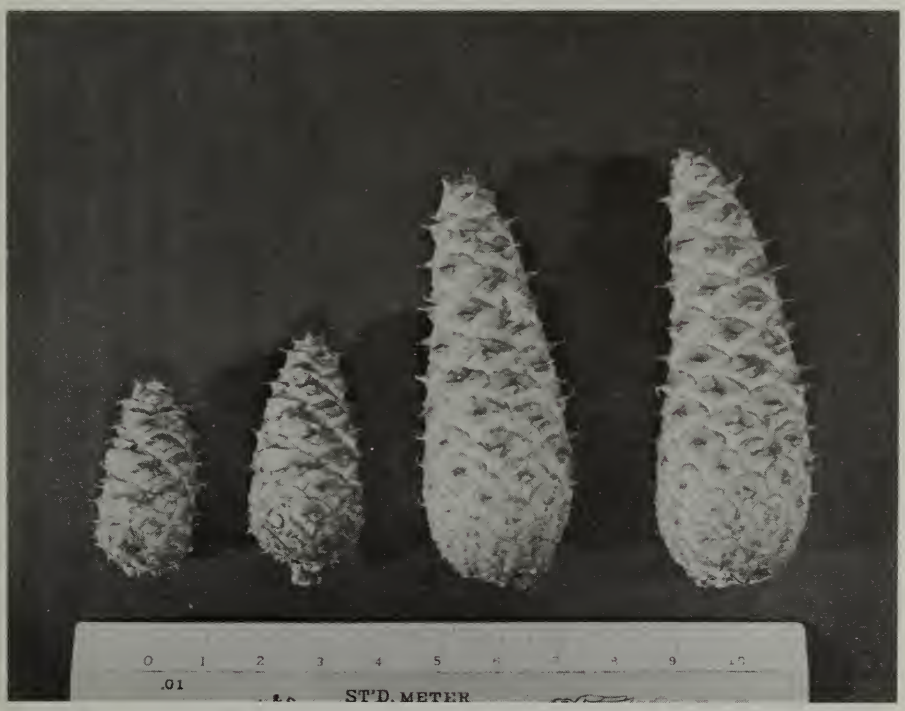

Figure 2.--*Virginia pine cones from different trees vary considerably in size.*

the second year and produce shoots. Fascicle buds may develop and produce shoots when terminal stem or branch buds are destroyed. Thus, there are several possible origins for shoots from the lower stem. All such shoots originate from previously existing buds; no adventitious shoots are produced *(64)*.

Figure 3.--*Mature Virginia pine left as a seed tree.*

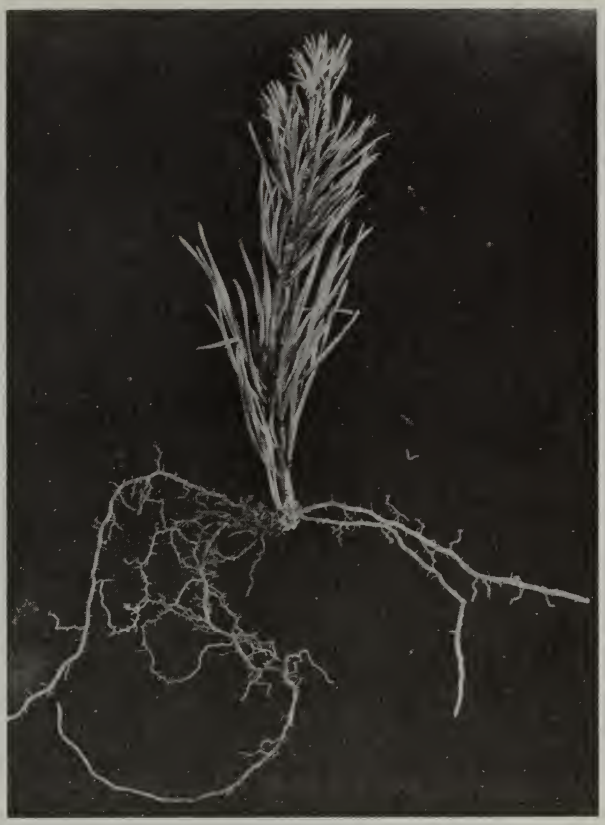

Figure 4.
Rooted cutting of Virginia pine.

The possibility of propagation from cuttings has been demonstrated *(50)*. Up to 30 percent of cuttings made in the winter from the previous season's growth were rooted in mist chambers. The cuttings were treated with hormones and grown under long-day conditions with supplemental artificial light (fig. 4).

SEEDLING DEVELOPMENT

Germination & Early Survival

Maximum germination and early survival occur when seeds fall on mineral soil *(7, 62)*. Even a thin layer of leaves or undecomposed needle litter reduces the chances for establishment *(7, 62)*. When the forest litter is disturbed during logging, or light surface fires precede seedfall *(40)*, density of seedling stocking increases. Burning slash after logging also assists in regeneration of Virginia pine (fig. 5). Collected seed remains viable for long periods when stored dry at 35° F.

Figure 5.--*Abundant reproduction (foreground) often follows slash-burning after a stand is cut.*

Exposure of wet seed of Virginia pine to artificial light prior to sowing has resulted in greatly increased germination *(67, 50)*. Maximum response after 24 hours of water imbibition is obtained with about 30 minutes of exposure in the red portion of the light spectrum. The stimulus given to germination by this light treatment can be reversed completely by treatment with far-red light.

Establishment & Early Growth

Seedlings of Virginia pine require direct sunlight for good growth (fig. 6), and die when heavily shaded *(62)*. This intolerance to shade is the most important factor in the early growth of this species *(54, 56, 58)*.

The intolerance of Virginia pine may well be the direct result of its basic photosynthetic limitations: under a forest canopy seedlings apparently are incapable of maintaining a positive balance of photosynthesis over respiration and consequently fail to become established.

Figure 6.--*Virginia pine reproduces well in the open, and is particularly evident along roadsides.*

In studies of loblolly pine--a slightly more tolerant species--apparent photosynthesis of seedlings, with juvenile needles only, decreased rapidly when light intensities fell below about 3,000 foot-candles *(5)*. Secondary needles of loblolly exhibit even less photo-synthetic efficiency than juvenile needles *(36)*. There are no comparable data for Virginia pine. However, the average light intensity under a well-stocked stand of Virginia pine at mid-day may be as low as 400 foot-candles. Obviously seedlings of Virginia pine, being even less tolerant than those of loblolly, could not survive at such light intensities under well-stocked stands.

Another aspect of the effect of light on the growth of Virginia pine is of importance in growing planting stock in the nursery. Extra light from an incandescent source can double height growth (fig. 7) in one season *(50, 51)*. A high level of nutrition, coupled with the photoperiodic effect of long days, can quadruple growth. Long days also induce other effects in Virginia pine such as increasing internodal length, accelerating cycles of bud formation, and breaking

of bud dormancy *(20, 21)*.

The balance and relative abundance of inorganic elements in the soil solution is also important to establishment and growth of Virginia pine. Basic nutrition studies in irrigated sand cultures show that when either potassium or magnesium is supplied at 0.01 millequivalents (meq.) per liter, deficiency symptoms appear *(51)*. Amounts adequate for healthy height growth are 0.35 meq. of calcium and 2.0 meq. of magnesium per liter. The adequacy level for potassium may lie somewhere between 0.1 and 1.0. The minimum levels for nitrogen and phosphorous are 1.78 and 0.03 meq. per liter, respectively *(26)*.

Mycorrhizae, with their greater absorbing surface, are important in the movement of nutritive materials from the soil to the translocation system in Virginia pine *(46)*. One such ectotrophic mycorrhizae is *Rhizopogon roseolus* (Corda) Th. Fr. *(49)*. Three Hymenomycetes also form mycorrhizae on Virginia pine *(29, 30)*.

Although methyl bromide treatment of nursery soils to control detrimental soil organisms increases growth of Virginia pine seedlings *(31)*, mycorrhizal development is suppressed during the first year. Under this condition mycorrhizae become abundant again the following season *(52)*.

Virginia pine seedlings show varied responses to an applied growth substance such as Gibberellic acid *(41, 72)*. It seems that a positive growth response might be induced only under special, and as yet unknown environments.

Virginia pine seedlings are more tolerant of low moisture in the soil than most pines, and remain alive and

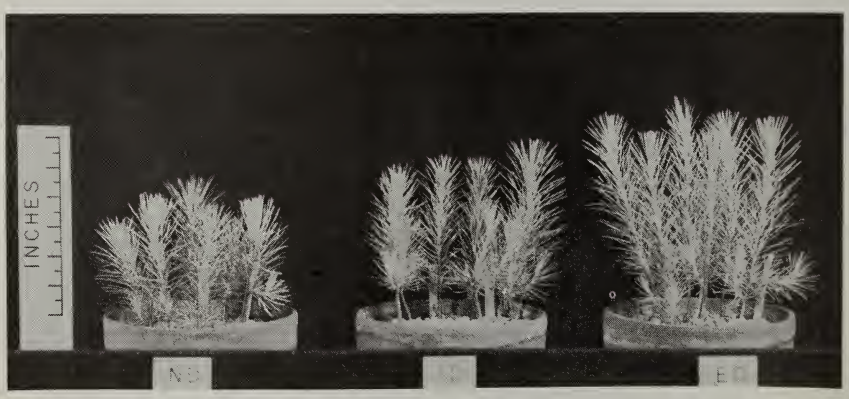

Figure 7.--*Virginia pine seedlings grow faster when given supplemental light in the middle of the night (ID) or by extending the natural length of day (ED).*

Figure 8.--*A typical old-field stand of Virginia pine, showing how the branches of the species persist.*

grow under quite dry conditions *(54)*. Although they survive when moisture is low, their rate of growth is slow. This rate is correlated with rainfall *(43)*.

Seedlings reach a height of 4 to 8 inches the first year when growth conditions are favorable. At the end of 10 years they may average 17 feet in height on the better sites *(59, 62)*.

SAPLING STAGE TO MATURITY

Growth & Yield

Diameter growth is faster in open than in dense stands *(62)*. Slow natural pruning results in persistent branch stubs *(54)* that remain on the tree for many years (fig. 8). This characteristic accounts for the large pro-

portion of knotty lumber sawed from this species *(24, 43)*.

Virginia pine will not respond to thinning unless the stands are less than about 15 years old *(8, 47, 74, 75)*. Opening up older stands is not advisable because this species is subject to windthrow and breakage by wind, ice, and sleet; residual trees exposed by partial cuttings are especially vulnerable *(23, 43, 59, 62)*. Because of its very shallow root system, Virginia pine is less windfirm than most southern pines.

Virginia pine planted on old fields does well. One plantation in Iowa *(33)* showed a mean annual height growth of 1.86 feet after 15 years, with an average basal area of 111.2 feet per acre *(32)*. This growth was better than that of five other pine species planted on the same sites. The mean annual diameter growth was 0.34 inches during the same period.

It also did well on some sites when planted in Illinois *(38)*. However, plantations in Missouri, Kansas, and Oklahoma were severely infested by Nantucket pine tip moth, and survival and growth were poor *(13)*.

The species is very susceptible to fire damage because of its thin bark; young trees are particularly vulnerable *(53, 59, 62)*.. Surface fires may cause considerable damage even to older stands.

Bark thickness at 9 inches above the ground varies from 0.3 inches for stems 4 inches in diameter, to 0.9 inches for 18-inch stems *(59)*. At a height of 20 or more feet above the ground, the bark thickness of trees larger than 5 inches d.b.h. ranged from 0.05 to 0.1 inches. Fast growth is indicated by thin, smooth bark *(78)*.

On average sites well-stocked stands may have as many as 1,600 stems per acre at 20 years of age *(43)* The number drops to about 200 in 70-year-old stands *(12, 43, 59)*. The average merchantable volume per acre in North Carolina for site index 60 averages 1,600 cubic feet at 20 years and 5,050 cubic feet at 70 years *(59)*. Published volume figures for Maryland *(10, 12)* are intermediate between the higher values for North Carolina *(48, 59)*, and the lower values for Pennsylvania *(43)*. On best sites the trees reach a height of 120 feet at maturity *(57, 62)*, but the average height varies from 50 to 75 feet *(43, 48, 59, 62)* at 50 years of age. Reports from widely scattered locations indicate a growth-rate capability of a cord per acre per year *(16, 19, 59, 62)*.

The mean annual growth rate for merchantable stands reaches its maximum at 40 to 50 years for pulpwood *(74)* and 70 years for sawtimber in Pennsylvania *(43)*. Here optimum

merchantable growth rate is reported to occur when the dominant (largest) trees are spaced about D + 6 *(44)* (average tree diameter in inches plus 6 equals spacing in feet).

Disease Pests

Heart rot due to *Fomes pini* is often present in stands older than 60 years (fig. 9), but rarely in stands under 50 years of age *(25, 59)*. In severe cases as high as 34 percent of the trees have been infected in a 59-year-old stand *(59)*. Other diseases of lesser importance to Virginia

Figure 9. *Fruiting body of* Fomes pini *on trunk of a 65-year-old Virginia pine.*

pine include the globose gall rust *(Cronartium cerebrum) (3, 77)*, a stem rust *(Cronartium appalachianum) (34)*, a needle rust *(Coleosporium pinicola) (28, 32)*, the Atropellis canker *(Atropellis tingens) (17)*, the pitch canker *(Fusarium lateritium) (35)*, sooty mould *(77)*, and witches'-broom *(27)*. A root rot *(Fomes annosus)* and a butt rot *(Polyporus Schweinitzii)* are reported to infect Virginia pine occasionally.

Insect Pests

The principal forest insects that cause significant damage to Virginia pine are the southern pine beetle *(Dendroctonus frontalis)*, Ips species, the Nantucket tip moth *(Rhyacionia frustrana)*, and the pine sawfly *(Neodiprion pratti pratti)* (fig. 10). Damage is cyclic, with build-ups from infestation foci, which spread and reach a peak, followed by a decline *(59, 62)*. Trees damaged by lightning,

Figure 10. *Sawfly damage and larvae* (Neodiprion pratti pratti) *feeding on pine needles.*

fire, or logging injury are more susceptible to insect attack than sound healthy trees.

At times insects damage cones severely and thus reduce seed yields. The cone insect that does most damage is a beetle *(Conopthorus virginianae)* specific to Virginia pine *(15)*. The less damaging cone moth *(Laspeyresia toreuta)* attacks Virginia pine, but usually destroys only a few seeds in each cone *(4)*. Chalcid flies, as yet unidentified, also do some damage. These insects lay their eggs in the immature seeds of young cones while the scales still are soft; such seeds subsequently are consumed by the larvae.

The Pales weevil *(Hylobius pales)*, which feeds on and often kills small seedlings of several pine species, may greatly reduce the regeneration of Virginia pine when the attack is severe *(59)*. Severe attacks are most likely on recently cut-over areas and on recent burns.

Other Pests

Many animals and birds retard regeneration by eating seed and destroying cones, but there is no measure of this loss. Under some conditions meadow mice girdle young trees, causing considerable local damage *(11)*. In one instance field mice preferred Virginia pine over white, red, and ponderosa pine *(42)*. Mouse damage is usually associated with a heavy grass cover *(59)*.

Reaction to Competition

Being intolerant of shade, Virginia pine is a transitional type that is eventually replaced by the climax hardwood forest *(43, 55, 59, 62)*. It is a disaster species, coming in after fire, and on badly eroded areas or worn-out old fields. Compared to other associated pines, it is generally more aggressive on the poorer sites *(16)*. As environmental conditions improve, hardwoods become a definite part of the understory *(37, 45)*. These become the dominants and gradually take over the area in succeeding rotations, unless set back by such factors as fire and other means of retarding hardwoods *(45, 54, 55, 61)*.

Races and Hybrids

Few data are available on individual tree or racial variation. Recent seed-source studies for Virginia pine are showing considerable variations between lots the first year in the seedbed *(73)*.

No authenticated hybrids have been produced and reported in the literature. Negative results were obtained in species hybridization work *(22, 76)*. The cross *P. virginiana* x *rigida* and reciprocal failed to mature seed. The cross *P. virginiana* x *banksiana* and reciprocal matured some filled seeds, but no signs of hybridity were detected in the resultant 2-year-old seedlings. Virginia pine pollen used on female cones of knobcone pine *(Pinus attenuata)* failed to produce seed *(22)*.

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